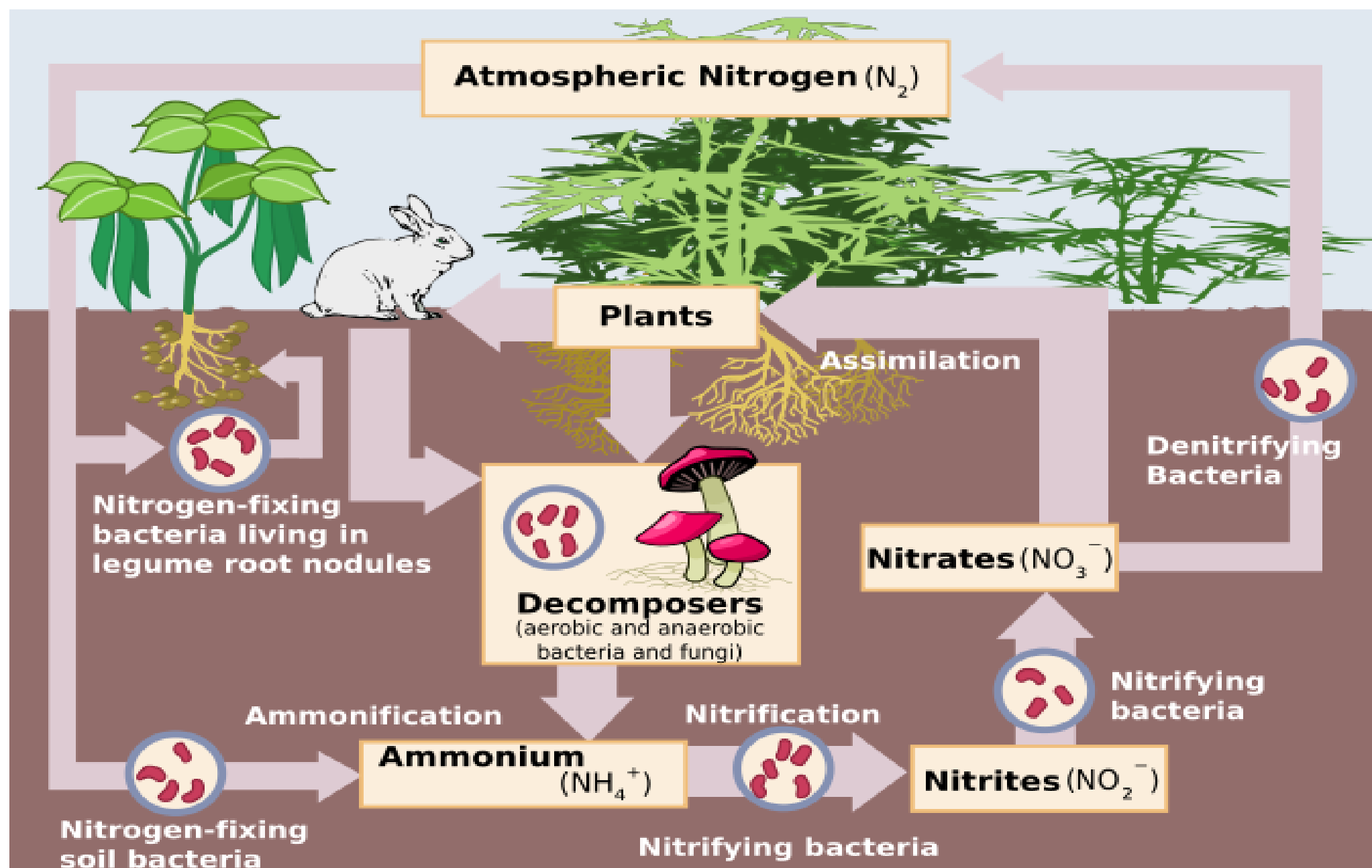


Biological Nitrogen Fixation (BNF)

Biochemical reduction of atmospheric inert- Nitrogen by certain micro-organism with the help of a special kind of enzyme (Nitrogenase). They contain to organic combination or to the form readily usable biological process is called Biological Nitrogen Fixation.

OR, The process of converting inert dry nitrogen into organic combination or in to other utilizable form Biochemically is known as BNF.



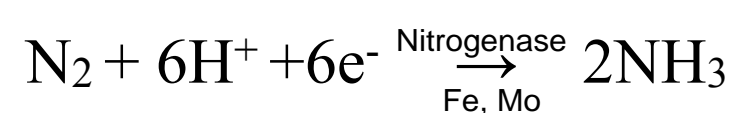
It is an important Biochemical reaction for life to the earth. Through these process certain organism converts inert di-nitrogen gas of the atmosphere to nitrogen containing organic compound that become available to all forms of life through Nitrogen Cycle.

Regardless of the organism involves, the key to Biological Nitrogen Fixation is the enzyme "Nitrogenase" which catalyse the reduction of di-nitrogen gas to Ammonia.

Reaction of BNF

It is completed in 2 steps-

1. Atmospheric N₂ reduce to NH₃ through the enzyme Nitrogenase.



2. NH₃ thus produced in synthesized to a stable compound protein.



Classification of BNF

BNF are mainly 2 types-

1. Symbiotic Nitrogen Fixation.

2. Non-symbiotic Nitrogen Fixation

1. Symbiotic Nitrogen Fixation: The Biochemical reduction of atmospheric inert dry nitrogen carried out by an association of two dissimilar organism living intimately to the soil and water in which both of the

partners are benefited. It may be following 2 types-

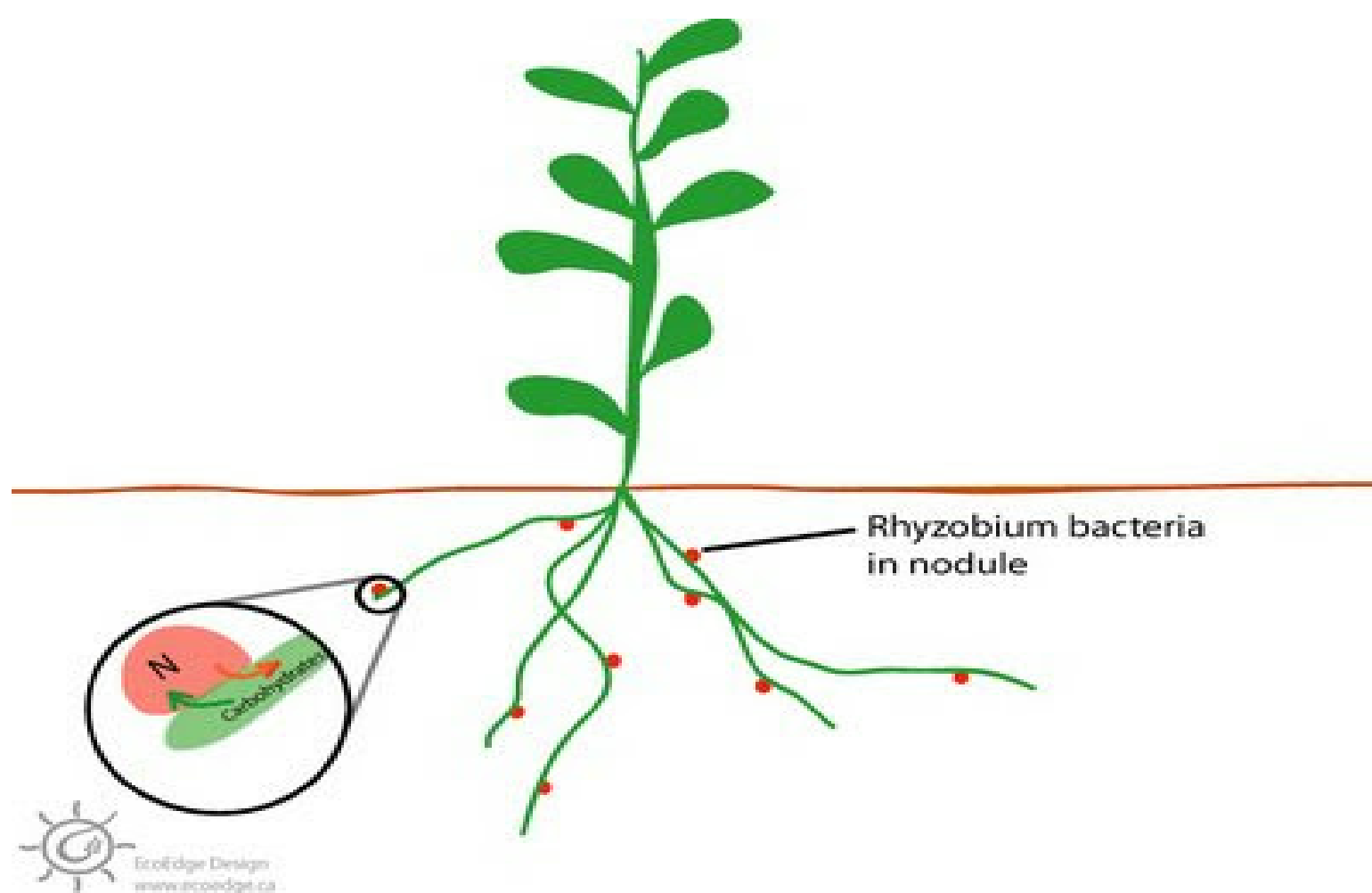
- **Leguminous Symbiosis-** e.g. legume-rhizobium symbiosis.
- **Non-leguminous symbiosis-** e.g. Azolla-Anabaena symbiosis.

2. Non-symbiotic Nitrogen Fixation: The Biochemical reduction of atmospheric inert dry nitrogen carried out by an individual organism living freely in soil and water. e.g. Azotobacter (aerobic), Clostridium (anaerobic), BGA etc.

Process of Legume-Rhizobium symbiosis

Establishment of Legume-Rhizobium symbiosis involves 2 way transfer of information *to the legume root* and *from legume roots to the Rhizobium*.

- Symbiosis begins with the colonization of the rhizosphere of young roots by rhizobium that can infect the particular host.
- The plant provides a sheathed "infection thread" which penetrates to the inner cortex and stimulates cortical cells to divide and produce the nodule structure.
- The developing nodule differentiates vascular tissues which flow of water, nutrients ions. The sugar to supply energy and nitrogen containing products like amides.
- Since Nitrogenase enzyme required for N_2 fixation is O_2 sensitive, it is controlled by legume haemoglobin in the nodule tissue. The haemoglobin makes healthy legume nodule pink coloured. Generally, nodule forms within 3 weeks after emergence of seedling.



In brief, The rhizobium inside the nodule fix significant amount of atmospheric N_2 which is used by the legumes in return. The rhizobium gets shelter by receiving other nutrients from the legumes.

Therefore, this is a symbiotic association where both the partners mutually benefited.

Azolla-Anabaena Symbiosis

Azolla

Azolla is a genus of its own family called Azollaceae. It is a floating water fern of world wide distribution. At present they exist 6 azolla sp. in nature.

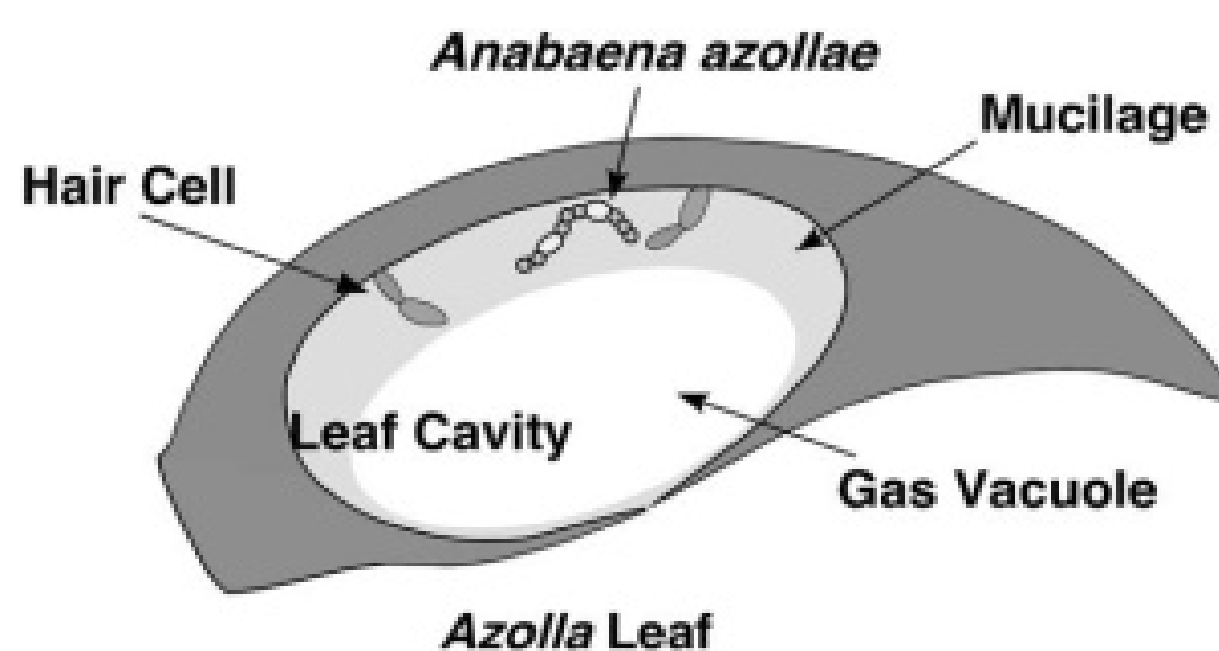
- Azolla consists of a floating branched rhizome with small alternate adventitious overlapping bi-lobed

leaves and simple roots which hang down into the water.

- The mature plant ranges from 0.5- 0.7 cm in diameter with simple individual roots which can produce a rhizome upto 40 cm or more with root bundle of 15 cm or more.
- The main rhizome bears several alternating branches cover with small overlapping leaves.
- The upper lobes is green i.e. chlorophyllous and perform photosynthetic activities. The lower lobe is achlorophyllous, colourless, transparent and remain in contact with water.
- It produces itself mostly vegetatively although sexual reproduction is also present.

Anabaena

The N_2 fixing BGA, Anabaena is almost invariably present in the *special cavity on the dorsal lobe* of each fern leaf.



Symbiosis Process

- In symbiosis, Anabaena fixes N_2 on the leaf of azolla and it supplies all of the N_2 needs of the host plant. Azolla takes the necessary nitrogen from the Anabaena and reproduces.
- Again Anabaena, takes up all other nutrients from azolla except N_2 . Thus azolla and anabaena are benefited each other.

This symbiotic relation between azolla and anabaena is known as Azolla-Anabaena symbiosis.

Write About Legume Crop

Legumes are angiosperms belonging to the order Rosales. All legumes belong to the family Leguminosae which is externally diversified comprising 750 genera, 2000 species of them are cultivated plants 100 agriculturally important legumes grown on 250×10^6 hectare of land. One bacteria of the genus Rhizobium forms a typical new organ known as nodule on the roots of the most leguminous plants.

The bacteria inside the nodule can fix significant amount of atmospheric Nitrogen which is being used by the legumes. In return bacteria gets shelter by receiving other nutrients from the leguminous plant. Therefore, this is a symbiotic association where both the partners are mutually benefited.

It has been found that 90% of Papilionaceae, 90% Mimosoideae and only 30% of the Caesalpinoideae form nodule.

The leguminosae family is sub-divided into 3 sub-divisions-

i) Mimosoideae

- 50 genera, 2900 species.
- mostly tropical.
- mostly trees and shrubs (vines) and only very few are herbaceous plant.

e.g. Acacia (*Mimosa indica*).

ii) Caesalpinoidae

- 100 genera, 1800 species.
- mostly hot climatic.
- mostly ornamental shrubs.

e.g. Termarind tree, wood tree etc.

iii) Papilionaceae

- 400 genera, 1400 species.
- world wide distribution.
- mostly herbaceous plant.

e.g. groundnut, Pea bean, lentil, Cowpea, pea, Soyabean etc.

Distinguish between symbiosis and non-symbiosis

Symbiosis	Non-symbiosis
The Biochemical reduction of atmospheric inert dry nitrogen carried out by an association of two dissimilar organism living intimately to the soil and water. This process is called symbiosis.	The Biochemical reduction of atmospheric inert dry nitrogen carried out by an individual organism living freely soil and water. This process called Non-symbiosis.
Two organism are responsible.	One organism is responsible.
It is impossible without 2 organism are living together.	It is possible to live alone.
Here, micro-organisms fix nitrogen in leguminous plant.	Micro-organisms fix nitrogen in non leguminous plant.
N ₂ fix in their roots and stem of the plant.	N ₂ fix their bodies.
The organism add N ₂ in to the soil before death.	Organism add N ₂ in to the soil after death.
E.g. Legume-Rhizobium & Azolla-Anabaena symbiosis.	E.g. Azotobacter, Clostridium, Nostoc etc.